WEIGHT AND HEIGHT IN RELATION TO MALNUTRITION

BY

WILLIAM R. P. EMERSON, M.D.

AND

FRANK A. MANNY

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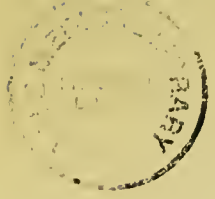

WEIGHT AND HEIGHT IN RELATION TO MALNUTRITION

By William R. P. Emerson, M.D., and Frank A. Manny.*

Malnutrition is a clinical entity with characteristic history, definite symptoms and pathological physical signs. The malnourished child is a sick child, and should be so classed. With this clinical picture in mind we have a check on the various weight tables in common use. The mere fact that a child is underweight according to a certain table does not necessarily mean that he is malnourished or even undernourished. The relationship between the individual child's weight and any table of average weights is evidence, but not conclusive evidence, of his physical condition. If the tables are based on proper data they should be not only a means of diagnosing malnutrition, but an aid in measuring its degree.

Proposed tests. In dealing, then, with any condition requiring correction in the individual child it is important to know, not only the actual facts of present status, but also the standard which ought to be met. In matters of growth various tests for its measurement have been proposed. Many of these are suggestive, and the field is well deserving of further investigation. The subject has been presented in another article[1] in which it is shown that none of these studies have as yet given much direct help except those concerned with development in terms of weight and height.

Weight and age. The basis most frequently used in discussion hitherto has been weight in relation to age. But in the clinic we were early impressed with the practical difficulties of a program which called for great effort on the part of the child to come up to the average weight for his age. The standard set was in many instances so far beyond his present achievement as to appear unattainable. He therefore became discouraged and made no progress at all. To attempt the impossible is not a reasonable means of reaching any goal but failure.

Height and age. The basis of height for age is even more confusing because many of the children most in need of care are above the average scale of height for their years.

Weight and height. One general physiological principle, how-

* Formerly Director of Nutrition Studies, Association for Improving the Condition of the Poor, New York City.

[1] F. A. Manny, Indexes of Nutrition and Growth. (See References.)

ever, seems to be applicable to all cases; that is, however tall or short a child may be, he requires sufficient body weight to sustain that height. In the many thousands of cases that have come under our observation we have never found an instance in which this basis has proved to be impracticable.

The malnourished. With this as a starting point the next step was to find what range of variation in the relation between weight and height was compatible with conditions of reasonably good health and growth. Ten per cent. underweight was taken as a working hypothesis, but it was soon evident that many children needing care did not come within this rule. After considering all the clinical evidence, we have found that an habitual 7 per cent. underweight for height is the most satisfactory dividing line.

This marks off the lower boundary of the safety zone. It does not indicate an ideal weight for height because children are found to be better off if they run 10 per cent. higher than this minimum.

The obese. A consideration of the upper boundary was afforded by the cases of children so much overweight that they showed impairment in activity and disposition, as well as a general lowering of their health, convenience and comfort. A study of our cases indicates that 20 per cent. overweight serves to distinguish the children who may be called obese.

The normal zone—stunted variants. This zone lying between 7 per cent. underweight and 20 per cent. overweight, separates the fairly normal group from those who should be under treatment at one extreme for malnutrition, and at the other for obesity. There are, however, a considerable number of children still left in the central zone who are definitely stunted; that is, not only underweight but also underheight. With proper health conditions these children soon prove that they have capacity for growth in both weight and height not heretofore realized. In this group are included those who are constitutionally affected by such conditions as syphilis, deficient thyroid, the effect of drugs such as caffeine and nicotine, and those recovering from such long continued illnesses as tuberculosis.

Individual diagnosis. We make it a rule to use the weight-height ratio for the purpose of selecting that large group of malnourished children most urgently in need of attention, and then

depend upon individual diagnosis to identify other cases not reached by the general rule. Any child who is clearly below the height and weight measurements usual at his age receives special consideration even though his ratio may be normal. In such a case an actual condition of good health and proper growth factors must be proved before it is fair to assume that the child is developing as well as it is possible for him to do.

Extent of malnutrition. The tests which we have applied to large numbers of children indicate that from 20 to 40 per cent. of the children of school and pre-school age in this country are habitually underweight for their height, and present both physical and mental signs of malnutrition. The results accomplished in nutrition classes show that under proper treatment and care practically all of these children can be made well in their own homes. The expression "made well" is used advisedly, for children who are habitually underweight for their height, are really sick, and present, practically without exception, in their history and on physical examination other distinctive signs of impaired nutrition which indicate that they are not only undernourished but malnourished.

The clinical picture. In the history we find the malnutrition coming on after a certain illness, or as a result of overfatigue, or of faulty food or health habits. At the same time the child becomes irritable, tires easily, lacks physical and mental control, and exhibits other indications of nervous disturbance.

Among the physical signs, besides the weight to height ratio, are lines under the eyes, anxious expression, pallor, mouth-breathing and other signs of nasopharyngeal obstruction; the anterior cervical glands are apt to be enlarged; the muscles flabby (tested by feeling the upper arm); there may be ptosis, fatigue posture, round shoulders, lateral curvature, flat chest, rigid spine, prominent abdomen and pronated or flat feet. By fatigue posture we refer to an appearance similar to the senile stoop due to weak muscles.

As the child approaches the normal there is clinical evidence of a transformation that is both physical and mental. There is a return of color and a glow of health that is unmistakable. Practically every parent states that the patient has "become a different child." Normal reactions appear, restlessness and irritability diminish, and the child ceases to be "finicky" and

"nervous." These are the same changes we look for after a long rest or a vacation.

Evidence of stunted growth. When conditions have been corrected for a malnourished child, nature apparently gives a strong initial impetus to his development. This is evidenced by the first rapid advance in growth, the rate of which is gradually reduced as he approaches normal condition. After the increase in weight has well started there is an increase in height also. This is more rapid than the rate of growth in the normal child—a sudden making up of the retarded growth following the removal of the causes which first made the child stunted. This is illustrated in Chart 1.

When a child is becoming malnourished, the loss of weight is very evident, but frequently the gain in height continues. The place of these two factors in practical work is suggested by Robertson in the following statement: "The variability of stature is much less than the variability of weight, from which we may infer that as a criterion of abnormality the measure of stature is more reliable than that of weight, while as a sensitive indicator of the effects of environmental, physiological or dietetic fluctuations, provided statistical methods of investigation are employed, the measure of weight is to be preferred to stature."

Vitiated tables. All tables of weight and height now in use are vitiated by the fact that they contain the measurements, not only of those who have accomplished normal growth, but also this 20 to 40 per cent. group who are habitually underweight for their height, as well as an undetermined number less underweight, but presenting other definite signs of malnutrition. It may be argued that the subnormal children are balanced in the tables by those who are overweight, but experience shows that the comparatively small number of cases sufficiently overweight to be considered abnormal are more than overbalanced by the borderline cases, without taking into account any of those who are clearly underweight for their height.

We need a record which has ruled out as far as possible, by physical examination, the groups described above. The remainder would furnish us data for physiological norms showing the range of normal children within a zone of healthy growth.

The foregoing paragraphs present the clinical evidence lying back of the tables which are here published.

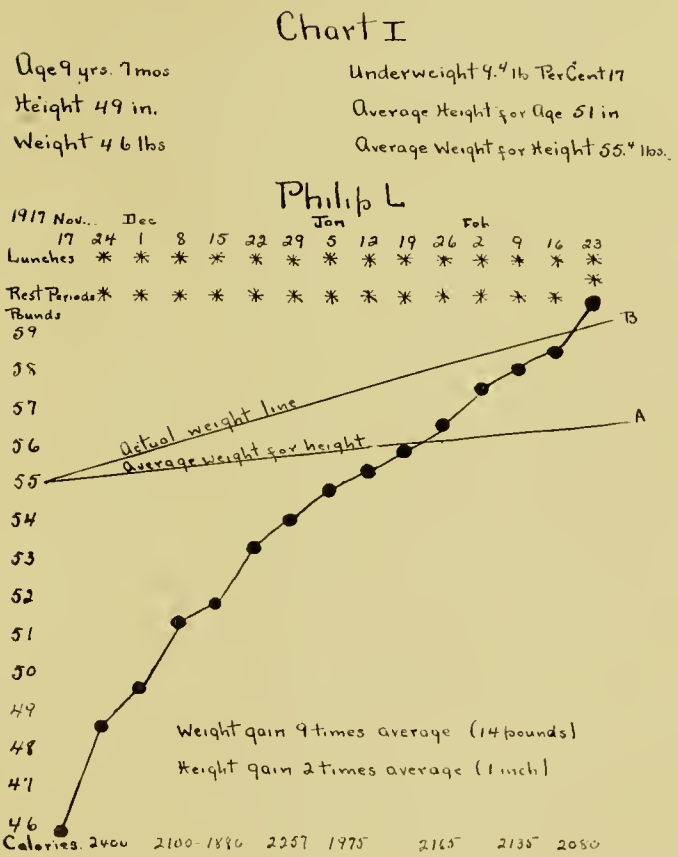

CHART I shows the record of a boy of 9 years and 7 months, who was 17 per cent. underweight for his height. During 14 weeks he gained 14 pounds in weight and 1 inch in height. Line A indicates his expected gain line as worked out when he first came to us. The fact, however, that during the time in which he was gaining rapidly in weight he also made twice as much gain in height as would be expected at his age is good evidence that he was below normal in height, which has to do with skeletal growth, as well as in weight for height. This would indicate that he was stunted and had capacity for growth beyond what he had attained. Further evidence of this statement appears clinically, for the boy was not up to normal when he had gained the 9.4 pounds which he lacked at the start. His gain in height required a new expected weight line (see line B on the chart) and it was only on reaching this new ratio that he became clinically well.

The constant occurrence of this change seems strong evidence that all children habitually 7 per cent. underweight for their height are retarded about a year in growth. The 7 per cent. by itself does not amount to this but the additional weight necessitated by the extra gain in height makes up the difference.

Sources of our tables. For the early years we have used for some time Holt's revised figures which he kindly furnished us before publication. These are now available in the latest edition of "The Diseases of Infancy and Childhood." The figures for children of school age we have taken for the most part from the basal studies of Boas and Burk which incorporate the work of Bowditch, Peckham, Porter and others, aggregating in all some 90,000 measurements. The results of their studies have appeared in two forms. One of these takes the mean of all measurements for each year of age at the half year[1], while the other, counts all those of a given year as if they were made at the beginning of the year[2]. This places the weights and heights of the latter version 6 months in advance of those of the former.

Tables set forward. The general correctness of the first form of the table is evident in any study which includes all the children examined, without excluding the 20 to 40 per cent. who are clearly below par. This is illustrated in Charts II and III. The wide use made of the latter form of the table, in which the figures are set forward half a year, has been due, no doubt, to the fact that it represents better than the other the measurements of fairly normal children.

On this account we have deliberately set the figures forward half a year in our tables because clinical work conducted both in the hospital and with so-called well children in school has shown that the curves on that basis represent better working standards than do any others now available. It will be observed that this form of the Boas-Burk figures articulates well with those of Holt's table for younger children, while the other form leaves a break in the line.

Such studies as those of Baldwin and Robertson, made on smaller groups of selected children, indicate results which run much higher than even our "set forward" figures. (See Charts IV and V). We have tested our tables by the various records referred to in Baldwin's bibliography and also by later investigations such as those made by the Metropolitan Life Insurance Company in their study of candidates for working papers, and that of Greenwood which includes 350,000 measurements of English school children.

[1] B. T. Baldwin, Physical Growth and School Progress, p. 150.
[2] J. L. Morse, Case Histories in Pediatrics, p. 13.

NUTRITION CLINICS FOR DELICATE CHILDREN

TABLE OF AVERAGE WEIGHTS OF CHILDREN AT VARIOUS HEIGHTS

Also Showing Weights 7% and 10% Underweight for Height

BOYS				GIRLS			
Height Inches	*Average Weight for Height Pounds*	*7% Under-weight Pounds*	*10% Under-weight Pounds*	*Average Weight for Height Pounds*	*7% Under-weight Pounds*	*10% Under-weight Pounds*	*Height Inches*
*21	8.2	7.6	7.4	7.9	7.3	7.1	21*
*22	9.7	9.0	8 7	9 4	8.7	8.5	22*
*23	11.1	10.3	10.0	11.0	10.2	9 9	23*
*24	12.5	11.6	11 3	12 5	11.6	11.3	24*
25	13.9	12.9	12.5	14.0	13 0	12 6	25*
*26	15.3	14.2	13.8	15.5	14 4	14 0	26*
27	16.9	15 7	15 2	17.2	16.0	15 5	27
*28	18.5	16.2	16.7	18.8	17 5	16 9	28*
*29	20.2	18.8	18.2	20.5	19.1	18 5	29*
*30	21.7	20.2	19.6	22 0	20 5	19 8	30*
*31	23.2	21.6	20 9	23 4	21 8	21 1	31*
*32	24.5	22.8	22.1	24 8	23 1	22 3	32*
*33	25.9	24.1	23 3	26 0	24 2	23 4	33*
*34	27.3	25.4	24 6	27.3	25 4	24 6	34*
*35	28.7	26.7	25 8	28 6	26 6	25 7	35*
*36	30.0	27 9	27.0	30 0	27 9	27.0	36*
*37	31.6	29 4	28.4	31.5	29 3	28.4	37*
*38	33.2	30 9	29.9	32 7	30 4	29 4	38*
39	36.3	33 8	32.7	35.7	33 2	32.1	39
10	38 1	35.4	34 3	37 4	34 8	33 7	10
41	39 8	37.0	35 8	39 2	36 5	35 3	41
42	41 7	38.8	37.5	41.2	38.3	37.1	42
43	13 5	40 5	39.2	43 1	10 1	38 8	43
44	15.4	12 2	40 9	14.8	41 7	40 3	44
45	17.1	43.8	42 4	46.3	43.1	41 7	45
16	49.5	46 0	44 6	48.5	45 1	43 7	46
47	51.4	47.8	46 3	50 9	47 3	45 8	47
48	53.0	49.3	47.7	53.3	49 6	48 0	48
49	55.4	51.5	49 9	55 8	51 9	50 2	49
50	59.6	55.4	53 6	58.3	54 2	52 5	50
51	62.5	58 1	56 3	61 1	56 8	55 0	51
52	65 8	61 1	59 2	63 8	59 3	57 4	52
53	68 9	64.1	62 0	66 8	62 1	60 1	53
54	72.0	67.0	64 8	70 3	65 4	63.3	54
55	75.4	70 1	67.9	74 5	69 3	67 1	55
56	79.2	73.7	71.3	78 4	72 9	70 6	56
57	82 8	77 0	74 5	82 5	76 7	74 3	57
58	87.0	80 9	78.3	86 6	80 5	77 9	58
59	91 1	81.7	82 0	91 1	84 7	82 0	59
60	95 2	88.5	85 7	96 7	89.9	87 0	60
61	99.3	92.3	89 4	102 5	95 3	92 2	61
62	103.8	96 5	93 4	110 4	102 7	99 4	62
63	108.0	100 4	97 2	118 0	109 7	106 2	63
64	114.7	106 7	103 2	123 0	114 4	110 7	64
65	121.8	113 3	109.6	130 0	120.9	117.0	65
66	127.8	118.9	115.0	137 0	127 4	123 3	66
67	132.6	123.3	119.3	143 0	133.0	128 7	67
68	138 9	129 2	125 0	146 9	136.6	13[illegible]	68

*Without Clothing.

TABLE OF AVERAGE WEIGHT AND HEIGHT MEASUREMENTS AT VARIOUS AGES

BOYS

Age		Height in Inches	Weight in Pounds	Age		Height in Inches	Weight in Pounds
Years	Months			Years	Months		
Birth	0	*20 6	* 7.55	9	0	50 0	59 6
	2	*22.5	*10.4	9	2	50 3	60 6
	4	*24.5	*13.2	9	4	50 6	61.5
	6	*26 5	*16.0	9	6	51 0	62.5
	8	*27.5	*17.7	9	8	51.3	63 5
	10	*28.5	*19.3	9	10	51 6	64 4
1	0	*29.5	*21.0	10	0	51.9	65.4
1	2	*30.3	*22.1	10	2	52.2	66.3
1	4	*31.1	*23.3	10	4	52 5	67 2
1	6	*32.0	*24.5	10	6	52.7	68 0
1	8	*32.7	*25.5	10	8	53 0	68 9
1	10	*33.4	*26.4	10	10	53.3	69 8
2	0	*34.0	*27.3	11	0	53 6	70 7
2	2	*34.7	*28.2	11	2	53 9	71 7
2	4	*35.4	*29.1	11	4	54 2	72 7
2	6	*36 0	*30.0	11	6	54.5	73 8
2	8	*36.5	*30 8	11	8	54.8	74 8
2	10	*37 0	*31.6	11	10	55.1	75 9
3	0	*37.5	*32.5	12	0	55.4	76.9
3	2	*38 0	*33.2	12	2	55.8	78 2
3	4	*38.5	*34.0	12	4	56 1	79 5
3	6	*39.0	*34.7	12	6	56.5	80 8
3	8	*39 5	*35.4	12	8	56.8	82.1
3	10	*40.0	*36.1	12	10	57 2	83.5
4	0	*40.5	*36.8	13	0	57.5	84 8
4	0	39 5	37.2	13	2	57 9	86 5
4	2	39.9	37.9	13	4	58 3	88 3
4	4	40.2	38.5	13	6	58 7	90.0
4	6	40 6	39 2	13	8	59 2	91.8
4	8	41 0	39.8	13	10	59 6	93 5
4	10	41.4	40.5	14	0	60 0	95 2
5	0	41.7	41.2	14	2	60 5	97 2
5	2	42.1	41 8	14	4	61 0	99 3
5	4	42.4	42 4	14	6	61 5	101.3
5	6	42.8	43 1	14	8	61 9	103.3
5	8	43.2	43.8	14	10	62 4	105.3
5	10	43.5	44.5	15	0	62 9	107.4
6	0	43.9	45 2	15	2	63.2	109.7
6	2	44.3	45 9	15	4	63 6	111.9
6	4	44.7	46 6	15	6	63 9	114.2
6	6	45.1	47.3	15	8	64 2	116.5
6	8	45.4	48.1	15	10	64 6	118.8
6	10	45.7	48.8	16	0	64 9	121.0
7	0	46.0	49.5	16	2	65.1	122.5
7	2	46.5	50.3	16	4	65 5	124.0
7	4	46.9	51.2	16	6	65 7	125.5
7	6	47.4	52.0	16	8	65 9	127.0
7	8	47.9	52.8	16	10	66 1	128 5
7	10	48.3	53.6	17	0	66 5	130 0
8	0	48.8	54.5	17	2	66 7	130 9
8	2	49.0	55.4	17	4	66.8	131 7
8	4	49.2	56.2	17	6	67 0	132 6
8	6	49.4	57.1	17	8	67.2	133 4
8	8	49 6	57 9	17	10	67 3	134 3
8	10	49 8	58 8	18	0	67 4	135 1

*Without Clothing.

TABLE OF AVERAGE WEIGHT AND HEIGHT MEASUREMENTS AT VARIOUS AGES

GIRLS

Age		Height in Inches	Weight in Pounds	Age		Height in Inches	Weight in Pounds
Years	Months			Years	Months		
Birth	0	*20.5	* 7.16	9	0	49 7	57.4
	2	*22.3	* 9.9	9	2	50 0	58.3
	4	*24.2	*12.7	9	4	50.4	59.2
	6	*26.0	*15.5	9	6	50 7	60.2
	8	*27.0	*17.2	9	8	51.0	61 1
	10	*28 0	*18.8	9	10	51 4	62 0
1	0	*29.0	*20.5	10	0	51.7	62.9
1	2	*29.8	*21.7	10	2	52.1	64.0
1	4	*30.6	*22.8	10	4	52.4	65.1
1	6	*31.4	*24.0	10	6	52 8	66.2
1	8	*32 0	*24.8	10	8	53.2	67.3
1	10	*32 7	*25.6	10	10	53.5	68.4
2	0	*33.4	*26.5	11	0	53.8	69.5
2	2	*34.0	*27.3	11	2	54.1	71.0
2	4	*34.6	*28.1	11	4	51.5	72.6
2	6	*35.3	*29.0	11	6	54 9	74.1
2	8	*35.9	*29.8	11	8	55.3	*75.7
2	10	*36 5	*30.6	11	10	55.7	77.2
3	0	*37 0	*31.5	12	0	56.1	78 7
3	2	*37.5	*32.1	12	2	56.5	80.4
3	4	*38 0	*32 7	12	4	56 9	82.0
3	6	*38.5	*33.3	12	6	57.3	83 7
3	8	*39 0	*34 0	12	8	57.7	85 4
3	10	*39.5	*34 6	12	10	58 1	87.0
4	0	*40 0	*35 3	13	0	58.5	88 7
4	0	39 7	36 2	13	2	58 9	90.3
4	2	39 7	36 8	13	4	59 2	91 9
4	4	40 0	37.4	13	6	59.5	93.5
4	6	40.4	38.0	13	8	59.8	95 1
4	8	40.7	38.6	13	10	60 1	96 7
4	10	41.0	39.2	14	0	60 4	98.3
5	0	41.3	39.8	14	2	60.6	99.7
5	2	41 6	40 4	14	4	60 8	101.4
5	4	41.9	41.0	14	6	61 0	102.5
5	6	42.3	41.6	14	8	61.2	103.9
5	8	42.6	42.2	14	10	61.4	105.3
5	10	42.9	42.8	15	0	61.6	106.7
6	0	43.3	43.4	15	2	61.7	107.6
6	2	43.7	44.1	15	4	61.8	108.6
6	4	44 1	44.8	15	6	61.9	109.5
6	6	44.5	45.5	15	8	62.0	110.4
6	8	44.9	46.2	15	10	62.1	111.3
6	10	45 3	46.9	16	0	62 2	112.3
7	0	45 7	47.7	16	2	62.3	112.8
7	2	46.0	48.5	16	4	62.4	113.3
7	4	46.4	49.3	16	6	62.5	113.8
7	6	46 7	50.1	16	8	62.5	114.4
7	8	47.0	50 9	16	10	62.6	114.9
7	10	47.4	51.7	17	0	62 7	115.4
8	0	47.7	52 5				
8	2	48.0	53.3				
8	4	48 4	54 1				
8	6	48.7	55 0				
8	8	49 0	55 8				
8	10	49 4	56 6				

Without clothing.

TABLE SHOWING INCREASES IN WEIGHT AT VARIOUS AGES BY YEARS QUARTERS, AND WEEKS

BOYS

Age	Year—52 Weeks		Quarter—13 Weeks		Week	
	Pounds	Ounces	Pounds	Ounces	Pounds	Ounces
Birth to 1 year	13 45	215 2	3.3625	53.8	.259	4.14
1 to 2 years	6.3	100 8	1.575	25.2	.121	1 94
2 to 3 years	5.2	83 2	1.3	20.8	.100	1.60
3 to 4 years	4.3	68.8	1.075	17.2	.083	1.32
4 to 5 years	4.0	64 0	1.0	16 0	.077	1.23
5 to 6 years	4.0	64.0	1.0	16 0	077	1.23
6 to 7 years	4.3	68.8	1.075	17 2	.083	1.32
7 to 8 years	5.0	80.0	1.25	20.0	096	1.54
8 to 9 years	5.1	81.6	1.275	20.4	.098	1 57
9 to 10 years	5.8	92.8	1.45	23 2	.112	1.79
10 to 11 years	5.3	84.8	1.325	21.2	102	1.63
11 to 12 years	6.2	99.2	1.55	24 8	119	1 91
12 to 13 years	7 9	126.4	1.975	31.6	152	2 43
13 to 14 years	10 4	166.4	2.6	41.6	200	3 20
14 to 15 years	12 2	195.2	3.05	48 8	.235	3 75
15 to 16 years	13.6	217.6	3.40	54 4	.262	4.18

GIRLS

Age	Year—52 Weeks		Quarter—13 Weeks		Week	
	Pounds	Ounces	Pounds	Ounces	Pounds	Ounces
Birth to 1 year	13 34	213.44	3 335	53 36	.257	4.11
1 to 2 years	6 0	96.0	1.50	24 0	.115	1.85
2 to 3 years	5 0	80.0	1 25	20 0	096	1.54
3 to 4 years	3 8	60.8	.95	15 2	073	1 17
4 to 5 years	3 6	57 6	.9	14 4	.069	1 11
5 to 6 years	3 6	57.6	9	14.4	069	1.11
6 to 7 years	4 3	68.8	1 075	17.2	083	1 32
7 to 8 years	4 8	76.8	1 2	19.2	092	1 47
8 to 9 years	4.9	78.4	1 225	19 6	.094	1.51
9 to 10 years	5 5	88.0	1.375	22 0	106	1 69
10 to 11 years	6.6	105.6	1 65	26 4	127	2 03
11 to 12 years	9 2	147.2	2 3	36 8	177	2 83
12 to 13 years	10 0	160.0	2 5	40 0	192	3 08
13 to 14 years	9 6	153 6	2.4	38.4	185	2 95
14 to 15 years	8 4	134.4	2 1	33 6	175	2.59
15 to 16 years	5 6	89.6	1.4	22.4	108	1 72

The tables on pages 1 and 4 are based upon those on pages 2 and 3. The material of the latter for the first four years is taken from Holt's Diseases of Infancy and Childhood (1919)—that for the succeeding years is derived principally from the work of Boas, Burk, Bowditch and Smedley. The weights and heights in Holt's table are without clothing, while those of the later years are with indoor clothing but without shoes.

It will be noted that the figures for the later years differ from the Boas-Burk tables by six months. Our reason for setting the figures forward half a year is that in their original form they represent *averages* which include the very large number of children whom our clinical experience and studies of entire school groups find to be seriously malnourished. The tables in their present form run lower than those made in studies concerned mainly with normal children. As they are here printed they afford the best *working standard* for use until such a time as sufficient data are secured from weighing and measuring a large number of children who are normal.

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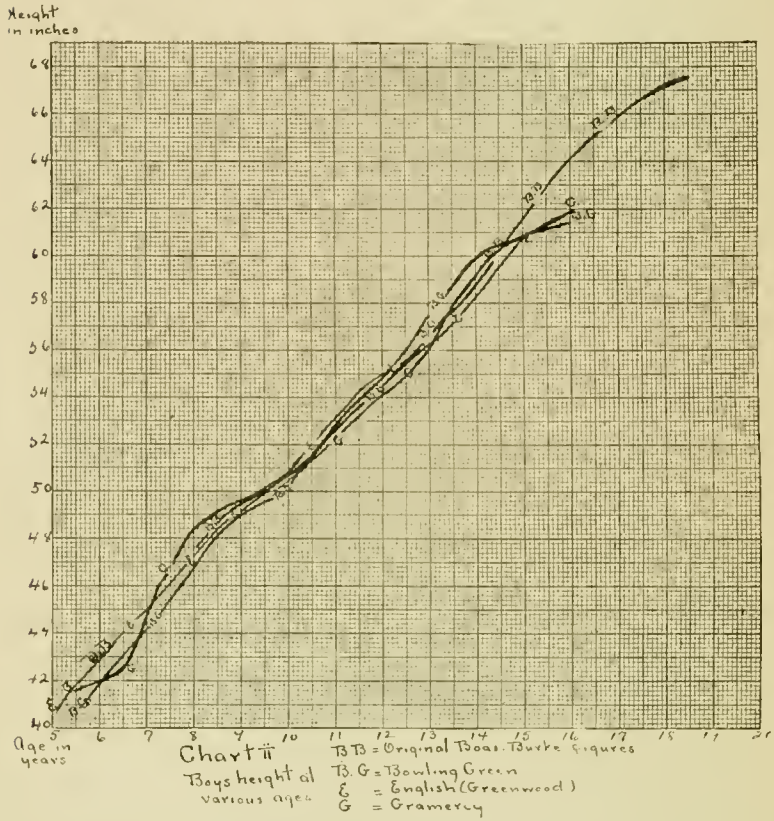
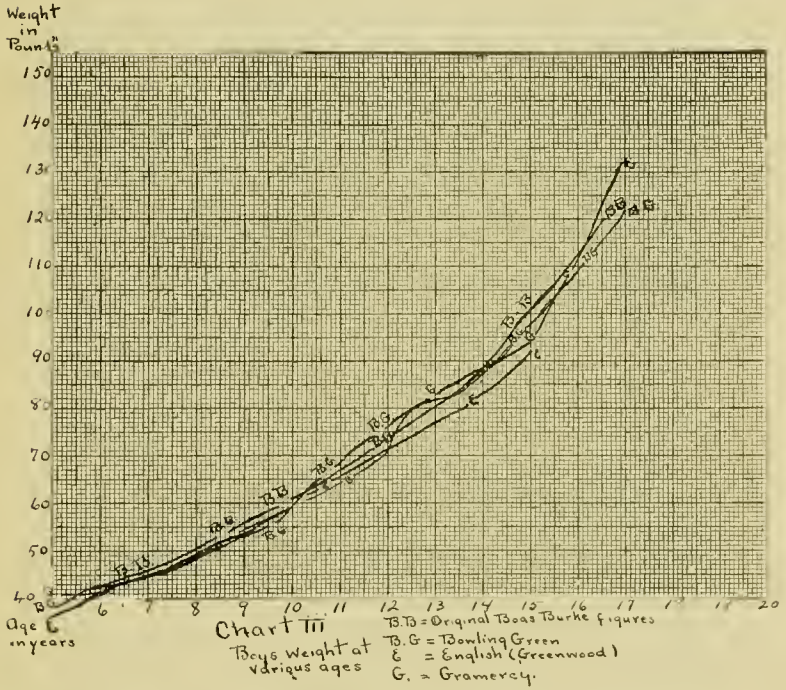
The zone standard. Wood has done valuable service in emphasizing the use of the zone system as opposed to any single line as a standard of reference. In the latest revision of his figures his results agree very nearly with the standard which we have adopted, although, as will be seen in Chart VI, he does not allow as wide a range of variation.



When we turn to age variations (see Chart VII) his range is less consistent, and we know of no clinical data which justify such modifications. For instance, according to Wood's latest table a girl of 7, with a height of 47 inches, should weigh 50 pounds, while a girl of 9, of the same height, should weigh 53 pounds. In his tables published in 1910 this was reversed, and the expected weight for the girl of 7 at the height given was

50 pounds, while the girl of 8 and 9, having the same height, had an expected weight of only 49 pounds. As Cannon states, "There is no physiological law which shows that a child should grow in height out of proportion to his weight. Furthermore, the average child has an average relation of height and weight."

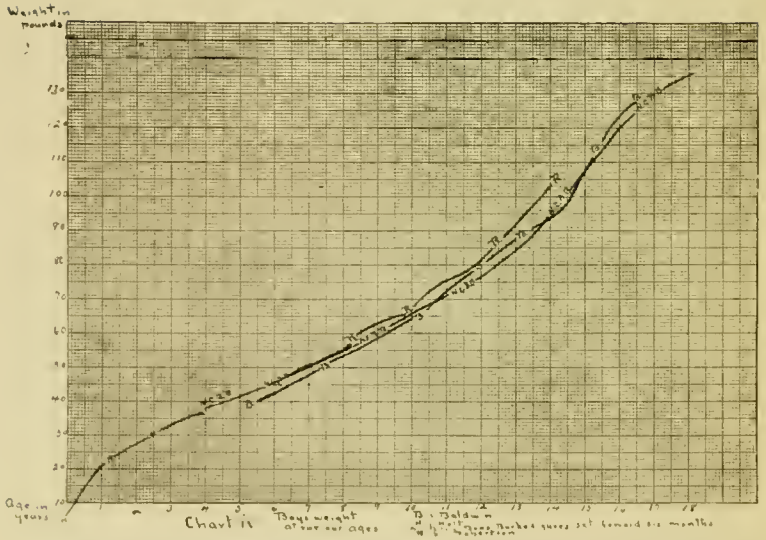
Within normal variations, therefore, we repeat that a given

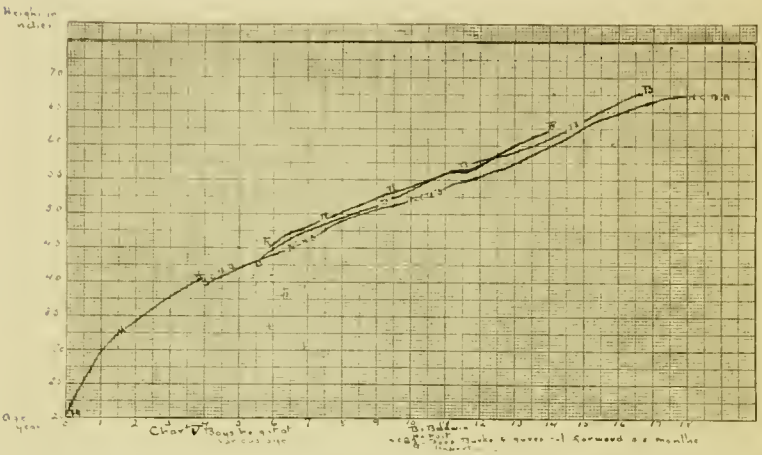


CHARTS II and III show how closely the measurements of height and weight of the pupils in four New York City schools, taken in 1917, agree with the averages in the original Boas-Burk tables. The pupils were in two groups—the Gramercy and Bowling Green districts—and numbered in all about 2500, of whom one-fourth to one-third were malnourished. Similar results are shown by including measurements of 350,000 English school children compiled by Greenwood in 1914.

height requires a certain body weight to sustain it at any age. The increase in weight which a child may be expected to make is, of course, modified by his age no matter what his nutritional condition because of the factor of adolescence. The relation between retardation of adolescence and malnutrition is a subject needing further investigation.

Retan has recently worked out a chart showing the zones of





CHARTS IV and V afford a comparison of the tables used in our nutrition clinics with the results obtained by Baldwin and Robertson from selected children measured without clothing. The former used some 30,000 measurements, and the latter 900. Note that even with the advance of half a year the line on which we base our standard runs *with clothing* below the lines of the more normal children measured *without clothing*.

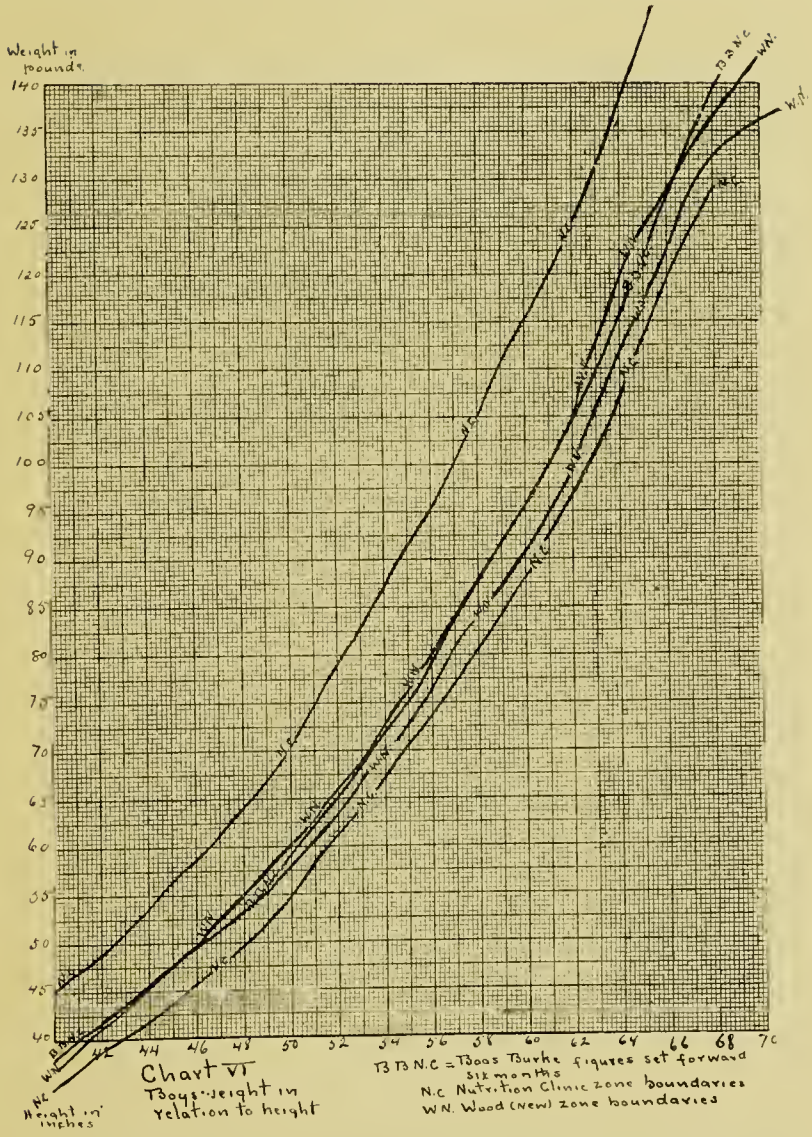
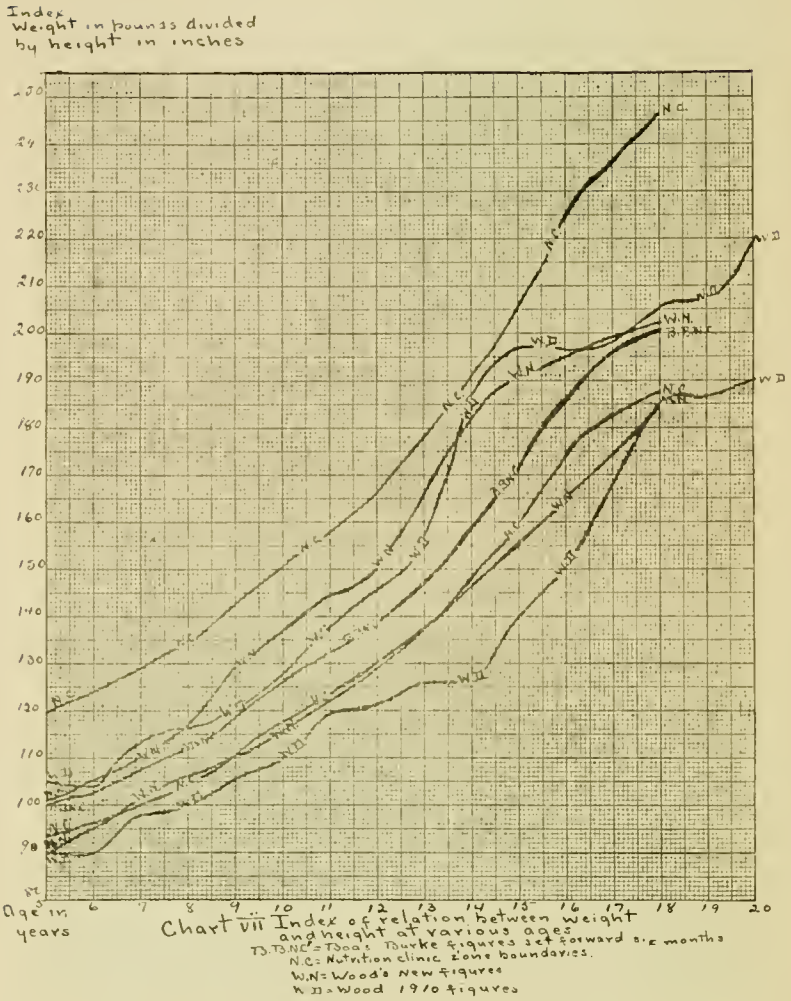


CHART VI shows the relationship between the zone boundaries which we use—7 per cent. underweight and 20 per cent. overweight for height—and those made by Wood for the use of the Child Health Organization. Note how closely Wood's lines follow the "set forward" Boas-Burk figures which we use as a basis. Wood's zone of health is much narrower than our clinical evidence justifies.



In Chart VI the comparison was kept to the relationship between weight and height, but in CHART VII the factor of age is also used. The weight and height factors are combined by using an index secured by dividing the weight in pounds by the height in inches. In addition to the figures prepared recently by Wood we have also included those which he published in 1910. Note that both his lower and upper zone boundaries are, on the whole, much higher in the later edition.

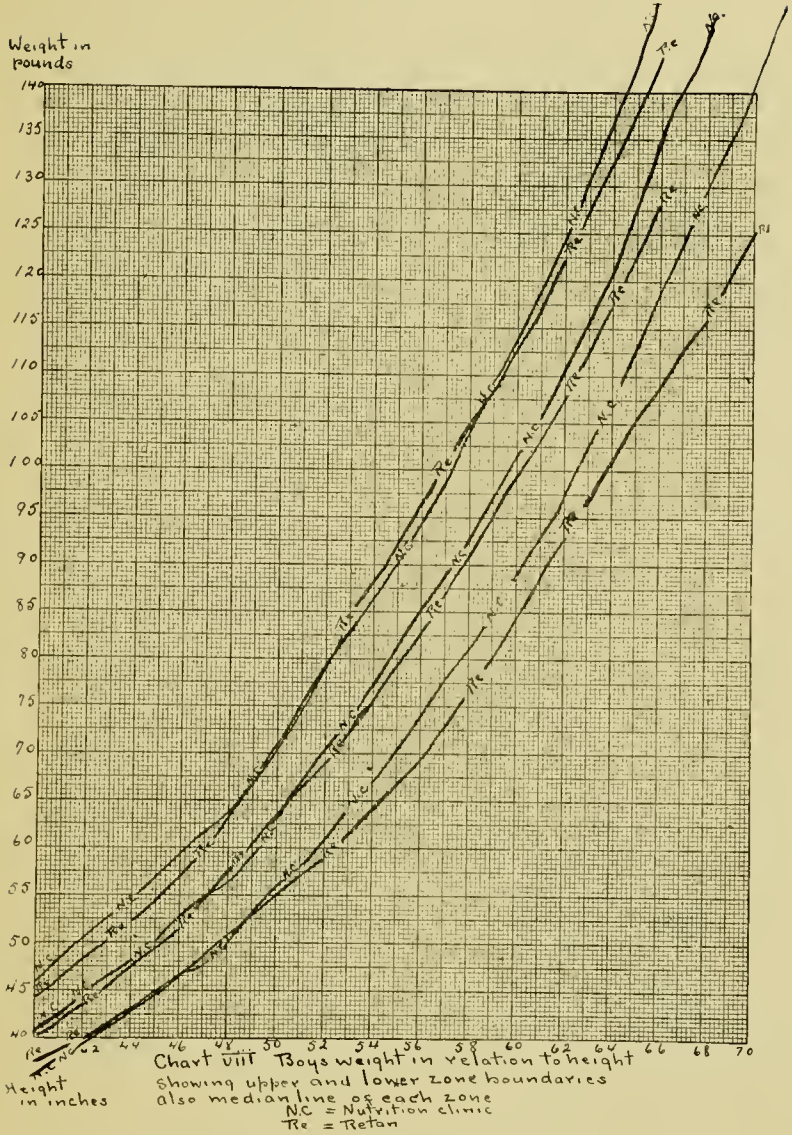


CHART VIII shows the zone boundaries determined experimentally by Retan. In plotting all children examined he made use of our general boundaries and then laid out his zones according to the actual location on the chart of obese and malnourished cases. The general agreement of the two sets of boundaries is here well illustrated.

nutritional condition. Starting with our tables, he has classified in zones all the children examined. The result reveals the malnourished children collected in the range of unsatisfactory relation between weight and height. Chart VIII shows how closely his evidence agrees with the boundaries we have worked out.

Sex and race variation. Sex variation is an interesting study in itself, but in the practical consideration of children up to the age of adolescence there is no reason for discussing the subject in this article. Therefore space has not been taken to publish parallel charts for the two sexes. To make comparison easier all the charts used are those showing the heights and weights of boys.

An objection frequently raised is that no single range of averages can serve for the various nationalities in an American city. We have tested our tables on the mixed population of several schools, and find that our range makes sufficient allowance in dealing with even the Italians and other types considered farthest below the average.

Seasonal growth. A section of this subject deserving special study is the matter of seasonal growth. It is commonly held that during certain parts of the year growth in weight leads, while growth in height is especially characteristic of other seasons. A summary of the literature of the subject is found in Hall's "Adolescence." Reference is made in the latest edition of Holt's "Diseases of Infancy and Childhood" to a study of 700 observations made on boys ranging in age from 9 to 16 years in a New York private school. This showed the period from May to November to have a decided advantage over the other 6 months in both weight and height increases. This result is ascribed to the greater freedom from illness and the larger opportunities for outdoor life during the open months. Added interest is given to this statement in the light of our experience which shows nasopharyngeal obstruction to be the most seriously disturbing physical factor with which we have to deal.

SUMMARY.

(1) Malnutrition is a definite clinical entity with characteristic history, definite symptoms and pathological physical signs.

(2) Clinical evidence shows that the physical sign which may

best serve to identify this group of malnourished children is the relationship existing between weight and height.

(3) The age factor is of secondary importance and is mainly serviceable in selecting cases stunted by constitutional disabilities such as syphilis, tuberculosis, deficient thyroid, the effect of certain drugs, convalescence from long illnesses, etc.

(4) The tables derived from the studies of Boas and Burk represent the most extensive records of weight and height measurements made. Recent studies show that they are essentially true averages of unselected groups of American children.

(5) The Boas-Burk and other tables in general use are vitiated by the fact that they include a large number of malnourished children whose measurements lower the averages of weight and height, thus making them of relative value only as standards.

(6) As a working basis it has been found necessary to set forward the Boas-Burk figures half a year, thus offsetting to a considerable extent the depression of averages stated above.

(7) Individual variation in the relationship of weight to height is of sufficient importance to make it necessary to use a zone system rather than any single line as a basis of reference.

(8) After various experiments at determining zone boundaries, clinical evidence is best satisfied by lines lying between 7 per cent. below and 20 per cent. above the "set forward" Boas-Burk figures. Outside of this central zone are found, on the one hand, the malnourished, and, on the other, the obese. Within the zone are still a considerable number of malnourished children requiring individual diagnosis.

(9) The malnourished children selected by this rule of habitual 7 per cent. underweight for height form, almost without variation, 20 to 40 per cent. of any group of children in school and pre-school periods.

(10) When tables have been constructed from a sufficient number of children proved to be normal, the line of average weights and heights will lie somewhere between the "set forward" Boas-Burk figures and those represented by a line drawn

midway between the 7 per cent. underweight and 20 per cent. overweight boundaries of the zone described above. Special studies of somewhat more carefully selected children, for example, those made by Baldwin and Robertson, confirm this statement.

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